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Supply Chains in Humanitarian Operations: Cases and Analysis

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Abstract

Efficiency in logistics is a key success factor because it ensures the proper flow of goods and services in a complex supply chain. Considering the need to quickly prepare humanitarian operations in response to a disaster, this paper presents an analysis of the logistics procedures adopted for the distribution of emergency reliefs in four major international disasters. Based on the analysis of these procedures, some basic guidelines for the supply chain distribution process in humanitarian operations were identified, which can support the development of models for rapid response to other similar events.

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1. Introduction

Natural events can be characterized as natural disasters when they occur in populated areas, causing the destruction of local infrastructure and population leading to a state of deprivation and suffering. In the last three decades, the occurrence of natural disasters has increased significantly.

Immediately after the occurrence of disasters, humanitarian operations are initiated with the intent to provide rapid assistance to victims in different ways, such as salvaging those who are wounded and/or stranded, collecting and disposing corpses, resource allocation, provision of food aid, shelter and medical care, and

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restoring access to remote locations. In humanitarian actions, delays in delivery or relief can cost lives. Therefore, efficiency in logistics is a key success factor, because it ensures the smooth flow of goods and services in a complex supply chain.

Logistics plays a key role in disaster response operations; it serves as a link between disaster preparedness and response, between procurement and distribution, and between headquarters and the field, and is crucial to the effectiveness and responsiveness to major humanitarian programs such as health, food, shelter, water and sanitation [1].

Considering the importance of logistics to the success of disaster response operations, this paper presents an analysis of the main logistics processes that were adopted in the distribution of relief supplies in three major international disasters that occurred in the last decade: the Indian Ocean tsunami in 2004, the earthquake in Pakistan in 2005 and the tsunami and earthquake in Japan in 2011. We will also demonstrate a comparative analysis with the operation response to the worst natural disaster in Brazil, the landslide in the mountain region of Rio de Janeiro in 2011. Based on the analysis of these processes, some basic procedures are identified that should be followed in the distribution process of a humanitarian operation's supply chain. Such procedures can serve as a basis for model development for rapid response in similar events, as the study of logistics in response to natural disasters is critical to operations performance and for current and future humanitarian programs.

This paper is structured as follows: Section 2 presents an overview of humanitarian operations in response to natural disasters. Section 3 describes the supply chain structure and operation in disaster relief. Section 4 discusses the humanitarian logistics decision making process. Through secondary data an analysis is performed evaluating the four disasters from the perspective of the aid distribution process (Section 5) and suggestions are presented for improving the effectiveness of the process when applied to other humanitarian operations (Section 6). Finally, Section 7 presents the final conclusions of the research.

2. The Humanitarian Response to Disasters

Humanitarian operations in disasters should be planned to allow a rapid and appropriate response, minimizing the impact of the disaster. However, according to Tatham and Houghton [2] the multiplicity of objectives of international humanitarian organizations, associated with an increased number of stakeholders involved, greatly increases the complexity of implementation and coordination of these operations.

Responses to disasters are usually multi-faceted and involve governments, nongovernmental organizations (NGOs), UN agencies, military and private sector organizations. According to Moore and Antill [3], humanitarian action should be led by one of the actors in the scene, who knows the business practices and academic theory in supply chain management. However, the individual goals of the various actors involved in humanitarian operations do not always lead to integrated and coordinated efforts. Besides, the different styles of management and administrative structures, together with the complexities of relationships between different organizations, undermine the implementation of effective strategies for the supply chain.

International humanitarian organizations have a responsibility among three groups of "stakeholders": (i) donors who provide funds for aid programs and development (Oloruntoba and Gray [4]), (ii) beneficiaries of the program, and (iii) the international community, which receives most of the information about the operations through the media. Barton [5] highlights a general concern of humanitarian organizations regarding how donors distribute aid, the reactive nature of funding, lack of will to fund expenditure aimed at management, donors' objectives that undermine organizations to act freely and growing pressure for accountability. However, little importance is given to indirect crucial services such as: information systems, supply chain management,

personnel training and disaster preparedness (Kovács and Spens [6]; Oloruntoba and Gray [4]; Van Wassenhove [7]).

3. Structure and Operation of Supply Chain Management in a Humanitarian Context

The Humanitarian Supply Chain, as well as for business purposes, includes the following activities: preparation, planning, procurement, transportation, storage, tracking and customs clearance [8]. One of the differences between supply chains for business and for humanitarian actions is the main focus. In business, the focus is the final consumer, who is the input source of funds for the entire chain. In the humanitarian case, the end user rarely participates in a business transaction, having little control over supplies. According to Heasip *et al.* [9], when applied to humanitarian action, the supply chain needs to be flexible and able to respond quickly to unpredictable events effectively (which can be the difference between life and death) and efficiently (to treat a greater number of victims) under heavy budget constraints.

According Smilowitz and Dolinskaya [10], the main challenge of humanitarian supply chain management is to establish a flow of donations from different sources (national and international) which are not always useful, timely, or appropriate, with minimal waste of resources. Also, disposing of the poor quality and overwhelming quantity of information is extremely important for the frequent decisions that need to be made. The management of a humanitarian supply chain involves the integration and coordination of a large dispersed group of experts with a view to ensuring the basic mission of humanitarian aid: "the delivery of products and/or services to the needy, whose immediate or long-term survival can depend on the efficient execution of operational activities of logistics and supply chain, including the crucial 'last fifty meters'" [9].

A generic model of supply chain applicable in many scenarios of humanitarian aid allows a unidirectional flow of goods and equipment to affected areas, especially to places where there is greater need for resources [11]. A simple model of supply chain for humanitarian aid, developed by Oloruntoba and Gray [4] is shown in Figure 1.



Fig. 1 - Model of a Humanitarian Supply Chain. Source: [4].

Among the difficulties to obtain the best performance of the supply chain for humanitarian aid, we highlight the administrative and logistical bottlenecks due to poor infrastructure for receiving aid and the multiplicity of agencies and governments [7]. According to Oloruntoba and Gray [4], a major difficulty in coordinating the humanitarian supply chain has strong ties to the political interests and military forces of donors and recipient countries, the requirements of the "industry of donors", and the lack of coordinated plans. Besides, Mileti [12] considers the geographical dispersion and insufficient or inaccurate communication between the field and the

bases of humanitarian organizations, as well as between different organizations, as factors that bring harm to the coordination of relief operations.

4. Decision Making in Humanitarian Logistics

According to Benini *et al.* [13], there are important types of information required to perform logistics in the humanitarian context: (i) needs information (needs assessment, size of the affected population and additional adversity vulnerability, damage levels, pre-existing poverty), and (ii) logistics information (distance from the hub, transportation capacity on a given day, access roads open on a given day, existing cargo handling orders).

Decision makers in the humanitarian context (humanitarian programs and logistics directors) require a more precise overview of the systems' interconnections allowing them to understand and predict the effect of system changes over time (Wielgosz [14]). Moreover, the delay in decision-making tends to affect, among other things, the efficiency of rescue teams to meet the needs of the victims in time.

As noted by Benini *et al.* [13], the identification of needs has a significant impact on the performance of logistics decisions. Particularly in the context of humanitarian action, these decisions vary with the types of commodities (food, clothing, shelter reconstruction materials) and the different phases of the response action. After the earthquake in Pakistan in 2005, shipments of aid were often the result of countless decisions, many of them taken on the difficult "trade-offs" for the allocation of scarce goods and logistical resources. These decisions using cognitive models about the tasks to be performed have considered variables such as the specific needs of survivors, inventories, transportation capacity, security conditions in the region and climate conditions.

Based on experiences and interviews during the earthquake in Haiti in 2010, Smilowitz and Dolinskaya [10] outline the following components of decision-making process for Humanitarian Logistics: resource allocation policies, needs assessment, uncertainty of demand and supply, location for storage and shipment of goods, type of vehicle fleet and technology, and uncertainty about routes and vehicles. According to Long and Wood [15] and Kovács and Spens [6], the areas which cause the biggest problems in the immediate response phase are: the coordination of receipt, the unpredictability of demand and the "last mile" to transport the aid to victims.

5. Disaster assessment from the perspective of the supplies distribution

An analysis of major natural disasters was performed to identify the key processes and/or actions taken in the context of the distribution of supplies for secondary purposes. The Table 1 presents the main characteristics of natural disasters studied, while Figure 2 indicates the focus of the study.

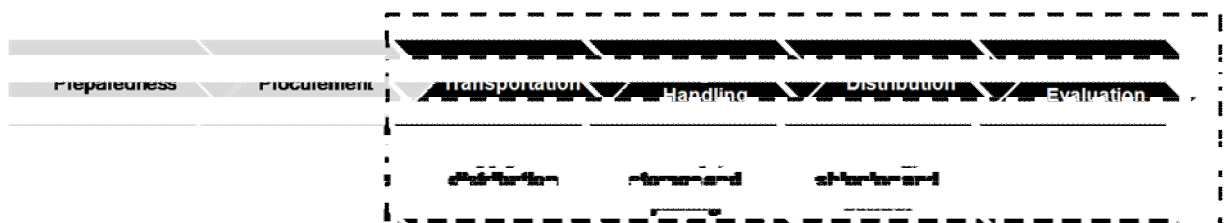


Fig. 2 - Focus of the study in humanitarian supply chain. Source: adapted from Thomas [1].

The study identifies the profile of the operations, their points of success and difficulty, and the search for similar and complementary points between needs and actions taken. The result indicates the critical points of decision-making process with lessons learned, and proposes a set of best practices that can be adopted by the managers of humanitarian aid operations.

Table 1 - Characteristics of natural disasters studied.

	Indian Ocean 2004	Pakistan 2005	Brazil 2011	Japan 2011
Sources	Telford and Cosgrave [16] Goyet, C.V. and Morinière, L. C. [17]	Khan [18] Aldo Benini <i>et al.</i> [13] ActionAid International [19] Tulloch [20]	Secretaria de Biodiversidade e Florestas [21]	World Health Organization [22]
Type	Earthquake followed by Tsunami.	Earthquake of 7.6 on the Richter scale.	Flooding with landslide.	On the first day after the earthquake, more than 50 aftershocks were experienced, seven of which measured at least 6.3 on the Richter scale, followed by tsunami. Cascading disaster: earthquake → tsunami → nuclear crisis → economic crisis
Population affected	1.7 million people.	3.5 million people.	36,083 people.	402,069 people evacuated.
Deaths	227,000 people.	73,000 people.	910 people.	15,848 people.
Exetnsion	14 countries around the Indian Ocean. Indonesia, Sri Lanka, Maldives, India and Thailand were the hardest hit.	Northern Pakistan and Indian Kashmir.	Municipalities of Petrópolis, Teresópolis, Nova Friburgo, Areal and São Jose do Rio Preto.	Coastal areas of southern Tohoku and Hokkaido.

5.1 Indian Ocean in 2004 (Sources: [16] [17] [23])

This disaster, the result of an earthquake followed by a tsunami, caused extensive destruction to 14 countries bordering the Indian Ocean. Its defining characteristic was the excess of NGOs involved and the overwhelming amount of donations made available. The low quality of operations and excess donated as unnecessary goods caused a supply chain overload that suffered with operational problems inherent in quantity and quality of local and international staff; inadequate methods, programs and tools, and little involvement in process management or coordination. Accordingly, the consequences were obstructed airports, excess containers blocking ports and customs areas, warehouses saturated, expensive materials and equipment deteriorating in the sun and rain, inadequate supplies and insufficient staff to provide records of materials, poor logistics reports and, in addition to losses, theft and sale of donations.

For planning purposes, poorly shared assessments associated with the limited capacity to provide them quickly and professionally led to the absence of complete lists of goods and people affected; this often created a random distribution of donations. Fortunately, the military participation proved to be essential to the operation, supplying the deficiencies of international institutions, especially with regard to the lack of capacity of air cargo. However, a joint coordination, planning and training with the humanitarian aid workers and military teams must be developed.

5.2 Pakistan 2005 (Sources: [13] [18] [19] [20])

Shaken by an earthquake of 7.6 on the Richter scale, the region north of Pakistan and Indian Kashmir in 2005 was the scene of one of the biggest natural disasters in the world, affecting approximately 3.5 million people. The situation became more serious due to four factors: the extremely rugged topography with affected areas at high altitudes; the level of poverty of the population, a looming winter which endangered the homeless and the permanent state of armed conflict in the region that establishes a state of insecurity.

The great challenge of humanitarian action in response to this disaster was the immediate need to perform simultaneously different aid activities, such as: evacuating the wounded, damage control, and supplying medical aid and products of first aid. The capacity to transport prevented the dispatch of relief goods to occur quickly and efficiently to the most deprived areas. This restriction, together with the fundraising, needs assessment, procurement of necessary goods and the difficulty of reaching remote locations were the set of constraining factors to the humanitarian operation.

The priorities adopted were: rescue and removal of dead and wounded, rapid deployment of forces and the immediate provision of shelter, food and medicine. To cope with the rugged geography of the affected region, both the road and the air transportation were used for the distribution: a large fleet of helicopters made deliveries to more than two hundred points. Despite the success of the operation in relation to the onset of winter, some regions did not receive three of the major groups of supplies (food, cooking supplies and water, shelter and clothing, construction materials and tools) due to deficiencies in the application of distribution models, showing the lack of appropriate mechanisms for tracking and control of aid flows from source to end user.

5.3 Japan 2011 (Sources: [22] [24])

In one of the most recent natural disasters, after an earthquake followed by 50 aftershocks, seven of which measured at least 6.3 on the Richter scale, a tsunami struck the coastal areas of Tohoku and southern Hokkaido, in a continuous stretch of over 500 km on the coastal areas of the island of Honshu. The succession of these events forced the evacuation of 402,069 people and led to the deaths of 15,848 other victims. The nuclear power plant in Fukushima was reported to be a potential public health emergency, making it a concern internationally, reaching a level 7 on the International Nuclear Event Scale (the highest).

The lack of electricity and water paralyzed hospitals located further inland. In addition, public health workers were also affected by the tsunami (with many losing their lives), leading to a lack of human resources for medical care. The disaster affected the infrastructure of transport, communications and logistical support, besides causing an interruption of fuel supply, a crucial factor for limiting all response activities. Thus, local governments were paralyzed or severely limited in their ability to perform initial assessments and to report the disaster extension.

The Japanese government established the following guidelines: provision of medical facilities (hospitals became operational, medicine and professional), roads release, restoration of the communication and information system, better use of scarce resources, reducing administrative barriers, coordination of supplies and medical equipment logistics, keeping governments and partners informed through situation reports, and providing shelter for victims. With considerable support from the WHO, World Health Organization, the Self-Defence Force, big logistics firms (UPS, DHL and FedEx), and based on information systems and communication supported by field surveys, some important actions were taken :

- Support for local government to the rescue of the dead and funeral services;
- Guidance to local governments regarding medical and food care;
- Health professionals team training;

- Establishment of temporary housing units (designed to shelter people displaced for two or more years) in Miyagi and Iwate to reduce the number of people in evacuation centers;
- Sending managers to conduct needs assessments in the areas directly affected;
- Implementation of a screening system for medical services;
- Provision of specific beds and people to care for the elderly, children and people with special needs.

5.4 Brazil in 2011 (Sources:[21] [25] [26] [27] [28])

In January 2011, the Mountain Region of the State of Rio de Janeiro was hit by a flood followed by landslides, despite the issuance of notice of weather risk by the National Institute of Meteorology. This catastrophe was considered by the UN as the 8th largest landslide in world history [25].

The initial actions found serious constraints such as lack of information about the real extent of the disaster, looting and insecurity in some areas affected, lack of adequate transport for the operation, difficulties in the use of communications systems available due to the topography of the region, poor quality maps of the region available, lack of adequate floating equipment, reduced amount of equipment for the restoration of traffic, and great destruction of access to affected areas. Under these conditions, the government established the following guidelines: the establishment of communication with the affected areas, aerial and ground reconnaissance, the rescue of survivors, and the cleaning and restoration of access roads.

Despite the dedication of field teams, the planning and logistical issues observed deserve further evaluation:

- Lack of guidance and equipment to aid teams arriving at the affected locations;
- Difficulty and inexperience in the management of camps for displaced people (70 in total);
- Random distribution of donations, due to lack of information;
- Problems with logistical support to operational activities (food and fuel among others);
- The use of helicopters (which played an important role) needs improvements;
- Little or no qualifications of field personnel.

In general, several problems associated with coordination, planning, training, transport, storage and distribution were evident, in contrast to the willingness and ability for mobilization shown by the population, the motivation of the Armed Forces and the intensive use of social networks that enabled important results in operations. Table 3 summarizes the scores observed in the studied disasters, which may guide other studies.

Table 3 - Points for the observation from the disasters study.

Indian Ocean 2004	<ul style="list-style-type: none"> • The number and diversity of actors made coordinating simultaneously more expensive and less effective. • The military played a key role in disaster response due to limited capacity of the international humanitarian system, requiring observation of the high costs of military operations and coordination between them and civilians. • The large amounts of donations involved overloading many international agencies and national, provincial and local actors. • The proliferation of NGOs due to the low barrier of entry for the system allowed the entry of inexperienced and sometimes incompetent actors (the same occurred with private companies that participated in the aid). • There was no effort to ascertain the number of serious injuries, to record the medical staff received, hospitals and their ability to monitor its effectiveness or for that matter, to record the occurrence of mortality after the tsunami. • International organizations have often failed to adequately informing victims of the situation.
Pakistan 2005	<ul style="list-style-type: none"> • Some areas were chronically not supplied because of the model used for needs distribution, so five regions did not receive the three major groups of supplies. • Rapid decision-making processes have to give emphasis to a particular variable. • There is need for the establishment of appropriate mechanisms for tracking and control of aid flows from source to end user.
Brazil 2010	<ul style="list-style-type: none"> • Intensive involvement of the Armed Forces with the infrastructure and resources (equipment and personnel). • Need for better coordination of operations between the military and civilians. • More effective presence of civilian agencies in the region to support the affected population.

	<ul style="list-style-type: none"> • Improvement the use of helicopters for humanitarian operations. • Inadequate supply of food and fuel to units operating in the affected area. • Problems in the logistics of donations (receiving, organizing, sorting and delivery). • Difficulty in managing the shelters.
Japan 2011	<ul style="list-style-type: none"> • During one week, the only supplies that arrived to the affected communities were brought by the Self Defense Forces (SDF). • Five logistics companies offered their services to the authorities (preventing a huge humanitarian crisis). • Japanese officials, although the preparations were taken by surprise by the magnitude of the challenge. • SDF did an excellent job in search, rescue and delivery of basic supplies. • The need to integrate the private sector constructively before the disaster.

6. Best practices proposals

From the analysis performed on the four disasters presented in section 5, some points have been identified for further development, seeking a better performance in the process of distributing supplies in humanitarian actions for natural disasters. These actions can be classified based on Figure 2.

6.1. Transport

To map the risk areas and identify the availability of resources by type of transport (road, waterway, air) able to be mobilized in the shortest time in the occurrence of natural disasters. Thus, we must undertake a survey of transport service providers, as well as government entities or private organizations with fleets available that can assist in case of humanitarian operations, identifying the types of vehicles and their capabilities. In general, humanitarian operations largely use road and air transport. However, we must evaluate how best to use other modes (water and air transportation - helicopters), in order to more efficiently support distribution activities in both the strategy of shipment and logistical support to the operation.

6.2. Storage and Handling

Definition of points to receive goods (domestic and international donations) in order to objectively define the distribution by warehouse and storage in classes or "supply kits" to facilitate the distribution. At these points, the following actions occur: storage, handling, screening (to identify unwanted or rejected material), shipment and discharge of material rejected. In points with incoming international donations, it will be necessary to have a staff with knowledge of customs clearance, in order to avoid congestion at the entry point. Finally, it should qualify staff to work in the area, to reduce errors and avoid the congestion of airports and blocked warehouses. It should also analyze potential points for storage, belonging to government entities or private organizations, as well as identify the availability of equipment (forklifts, pallet conveyors, etc.) able to be mobilized in the shortest time possible.

6.3. Distribution

The definition of the number of distribution points should be made to minimize the distance to the beneficiaries, but they should be placed in community centers already established, and meeting places such as clubs, churches, etc. An efficient distribution program requires information data about the goods available and the people affected. The use of military activities in cargo handling and access roads clearance facilitates the humanitarian mission.

6.4. Performance Evaluation:

KPI's and targets for periodic evaluation, using data obtained from the field staff, enabling the effectiveness of actions and the efficient use of available resources. Development of standards, procedures and technical specifications for supplies.

7. Conclusions and recommendations for future works

It was possible to observe the occurrence of common logistical problems studied in the activities of the supply chain for humanitarian purposes, regardless of the type of disaster that occurred. Successful actions in certain disasters are often not replicated in other humanitarian operations in response to new disasters. Nor are adopted models for optimization of distribution operations used in this type of operation, which is hampered by the lack of information, resources and appropriate personnel. As a consequence, a succession of losses and waste of scarce resources is typical. This ultimately does not fulfill the main expectation of many victims: they want disaster relief to be timely, efficient and well-coordinated.

This article presents an analysis of the major natural disasters occurred in the last decade and it also attempts to identify a set of the best practices in the immediate response phase of a humanitarian operation. More studies in the area are still necessary in order to integrate both theoretical and practical solutions for the major issues presented. It is understood that an in-depth assessment, with an analysis of a greater number of humanitarian responses to natural disasters, will allow a more accurate view of these often missed opportunities and organizational solutions. A greater range of disasters with similar origins would be studied from different sources. The crossing of experiences and best practices will allow the identification of important points for the exchange and development of shared solutions.

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